Document reference: 2_7_iii_2025

Innova NanoJet CDA Pro Air Scrubber

The Liverpool Biovalidation Laboratory

Professor A.C.Fisher MBE MD PhD FInstP FIET FIPEM FAHCS CEng CSci CPhys
Consultant Clinical Scientist
Health Innovation North West (NHS AHSN NW),
Liverpool Heart and Chest Hospital, and
Dept of Physics, University of Liverpool
Mobile: 07825864195

Document reference: 2_7_iii_2025

Innova NanoJet Biovalidation Report March 2025

Introduction

This report relates to the Biovalidation of the Innova (the Client) NanoJet CDa Pro to the Liverpool Biovalidation Protocol modified (see the notes at each test report section) as per the Client's instructions at the laboratory of the NHS Health Innovation NWC at the Feedwater site, Moreton on Wirral. The Standard Protocol can be found at the end of the report or on the IAQS (Indoor Air Quality Society) website.

Methodology

The standardised method (the Protocol) for the biovalidation of air purifiers (a.k.a. air scrubbers) is developed for NHS Supply Chain. The Protocol determines the clearance rate of aerosolized *Micrococcus luteus* in a closed room-sized chamber achieved by the air scrubber under test. Aerosolization of the bacterium suspension is by venturi nebuliser. Air sampling is by a Coriolis air-to-liquid impinger. Collected samples are spiral plated on to agar plates. After incubation, colony development is quantified as the number of colony-forming units using a dedicated image processor. The microbiology laboratory is accredited to ISO/IEC 17025:2017. Clearance rates are inferred from data represented by a first order exponential decay model.

Due to different working principle of the Innova NanoJet device to the conventional UVC-, HEPA- and Electrostatic-based air purifiers, modification based on the 'Protocol' has been conducted. The exceptions from the 'Protocol' are listed before each set of data.

Validation of precipitated bacteria with the Innova NanoJet CDa Pro Air Scrubber to the modified Liverpool Biovalidation Protocol

Innova NanoJet CDa Pro

Room Size	53	m^3
Ceiling Height	2.2	m

Sampling

Impact samples were made using the MicroBio Impact Sampler:

- Flow rate: 100 litres/min
- Sampling time 30s

Agar plates were TSA (tryptic soy agar)

- Incubated at 30C for 48 hours
- Mnaual reading

  Specific to identifiable luteus cfu's

  Discarded if interfering fungal or 'non-specific' bacterial contamination

Trial Run

30 minutes
Impact sampling at [0,10, 20, 30] minutes (*viz* x4 samples)
Passive settle plates [0-10, 10-20, 20-30] (*viz* x3 samples)

T0 Bacteria Concentration 2400 to 3100 CFU/m^3

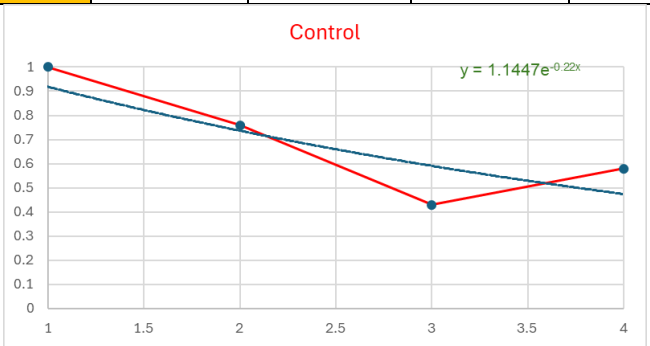
Trials were run as pairs of 'Controls' and '10 minute NanoJet treatments'

Fallow time of 2 hours between repeat runs

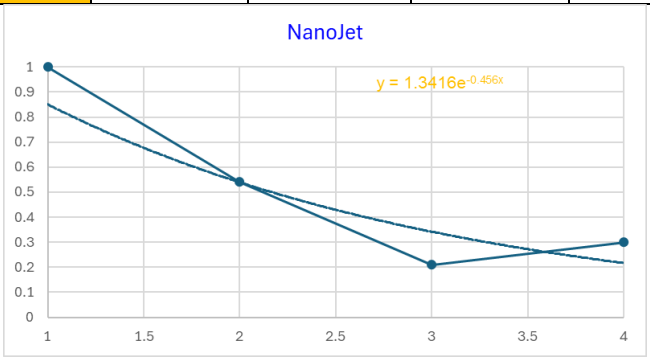
NanoJet configured to dispense horizontally towards different directions.

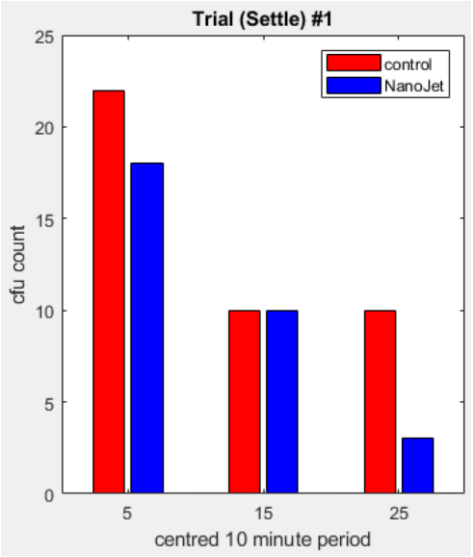
Room highly mixed with x4 fans set as per the Liverpool Protocol

11/03/2025				
Control	**Time (mins)**	**Counts**	**Norm.**	**Settle**
	Init (Zero)	144	1.00	22
	10	110	0.76	10
	20	62	0.43	10
	30	83	0.58	

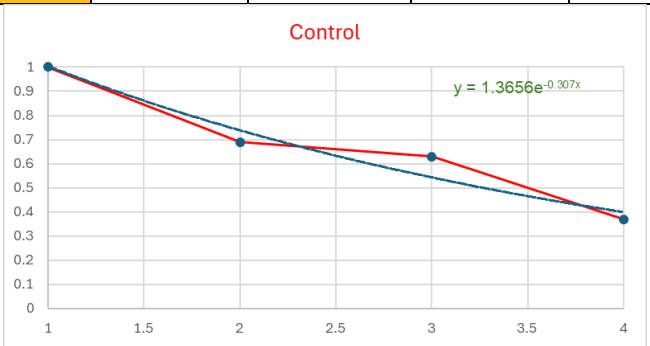


11/03/2025				
n=1	**Time (mins)**	**Counts**	**Norm.**	**Settle**
	Init (Zero)	154	1.00	18
	10	83	0.54	10
	20	32	0.21	3
	30	46	0.30	

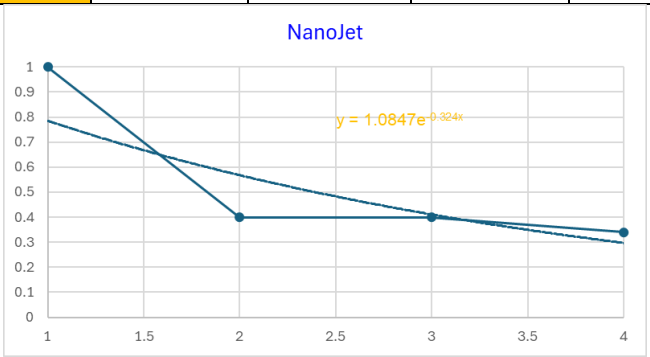


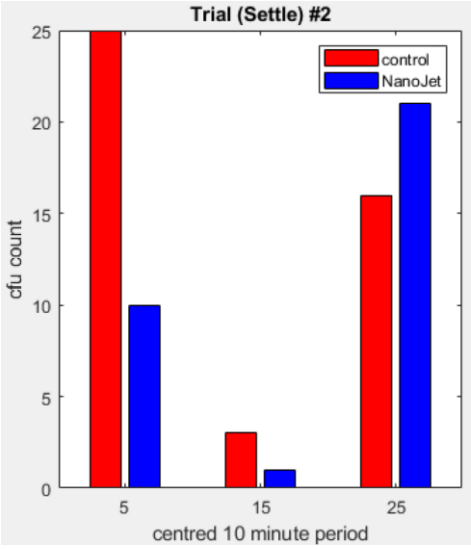


11/03/2025				
Control	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	147	1.00	25
	10	101	0.69	3
	20	93	0.63	16
	30	54	0.37	

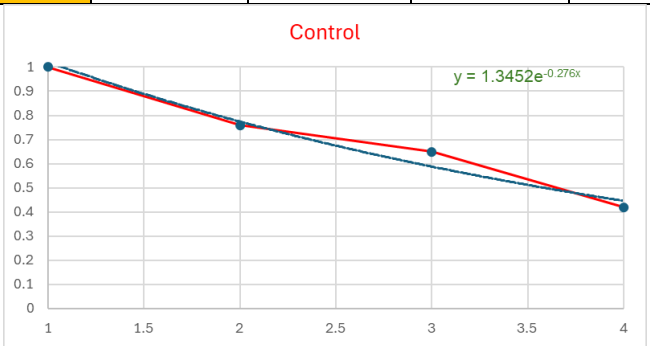


11/03/2025				
n=2	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	139	1.00	10
	10	56	0.40	1
	20	56	0.40	21
	30	47	0.34	

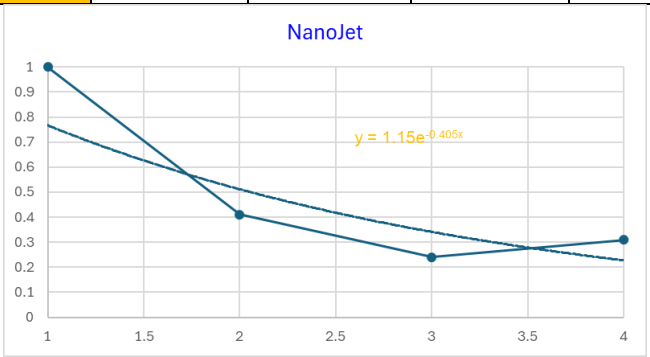


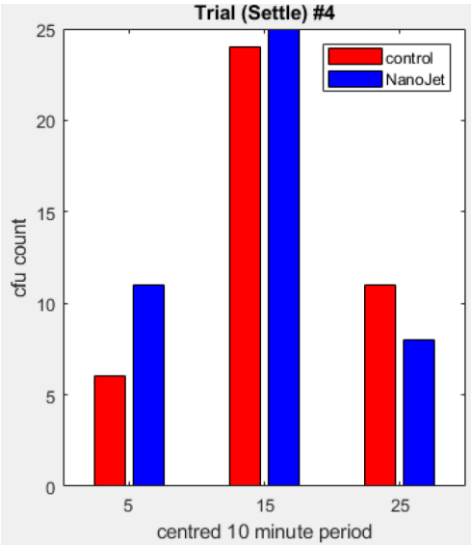


11/03/2025				
Control	**Time (mins)**	**Counts**	**Norm.**	**Settle**
	Init (Zero)	139	1.00	6
	10	105	0.76	24
	20	90	0.65	11
	30	59	0.42	

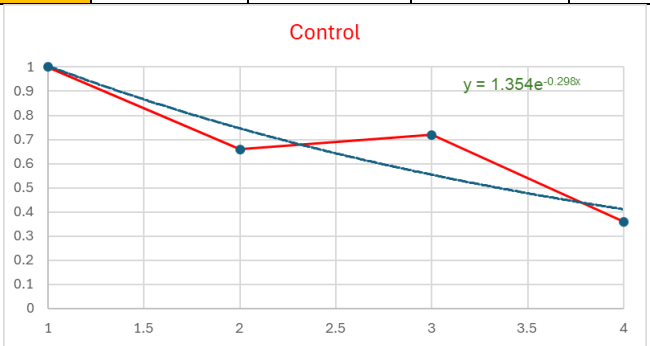


11/03/2025				
n=4	**Time (mins)**	**Counts**	**Norm.**	**Settle**
	Init (Zero)	127	1.00	11
	10	52	0.41	25
	20	31	0.24	8
	30	39	0.31	

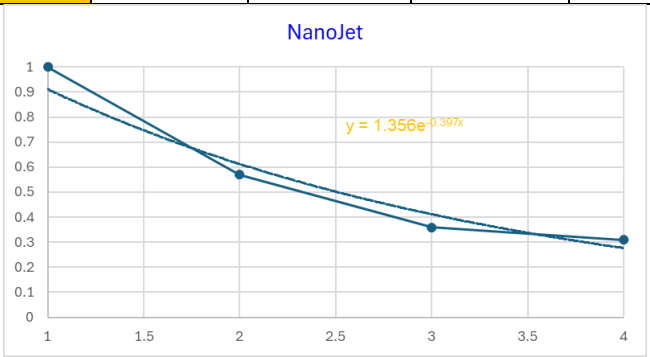


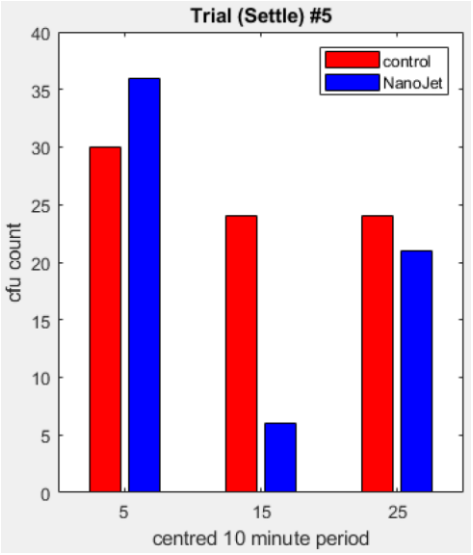


11/03/2025				
Control	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	137	1.00	30
	10	90	0.66	24
	20	99	0.72	24
	30	49	0.36	

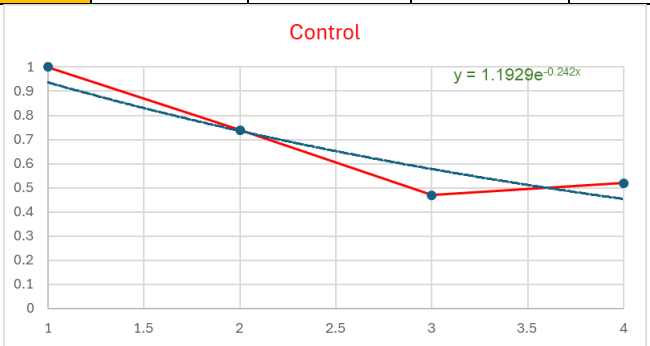


11/03/2025				
n=5	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	121	1.00	36
	10	69	0.57	6
	20	43	0.36	21
	30	37	0.31	

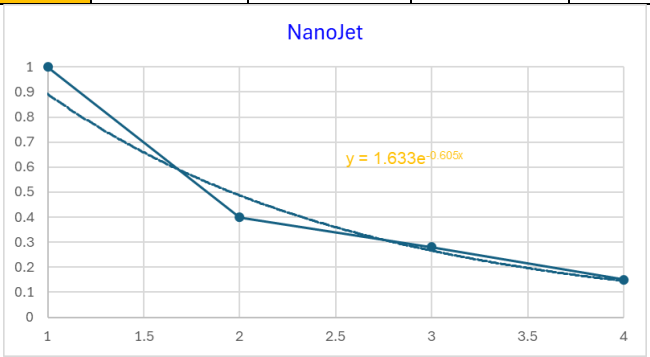


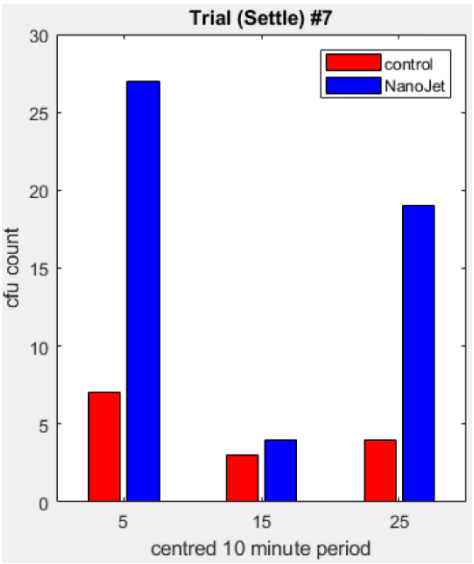


11/03/2025				
Control	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	141	1.00	7
	10	105	0.74	3
	20	66	0.47	4
	30	73	0.52	

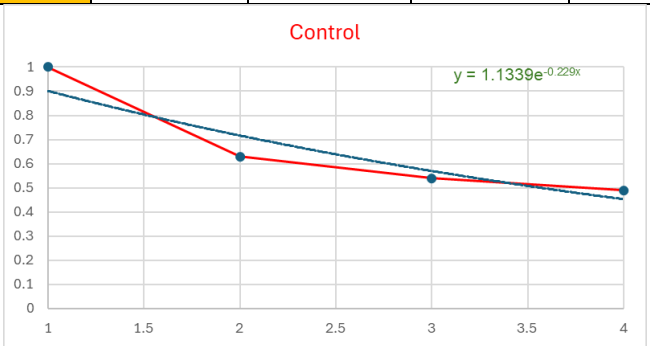


11/03/2025				
n=7	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	155	1.00	27
	10	62	0.4	4
	20	44	0.28	19
	30	25	0.15	

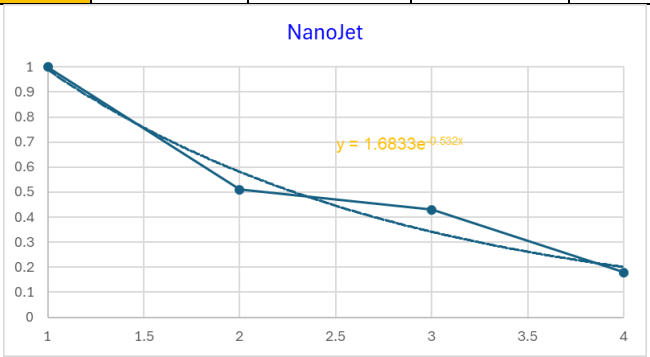


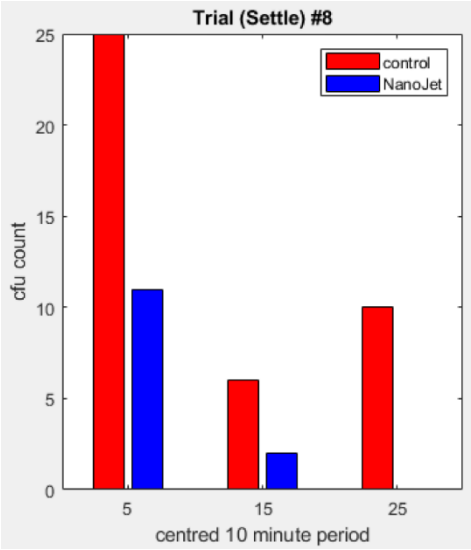


11/03/2025				
Control	**Time (mins)**	**Counts**	**Norm.**	**Settle**
	Init (Zero)	146	1.00	25
	10	92	0.63	6
	20	79	0.54	10
	30	71	0.49	

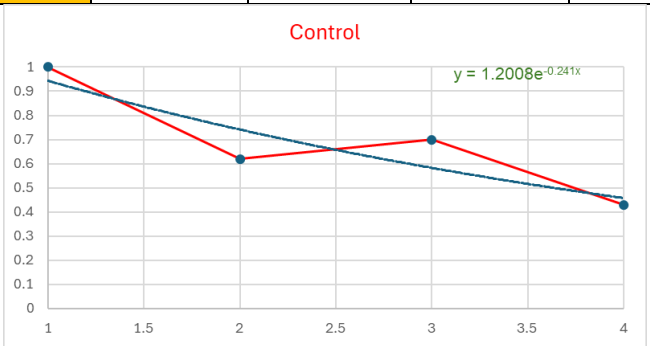


11/03/2025				
n=8	**Time (mins)**	**Counts**	**Norm.**	**Settle**
	Init (Zero)	125	1.00	11
	10	64	0.51	2
	20	54	0.43	0
	30	23	0.18	

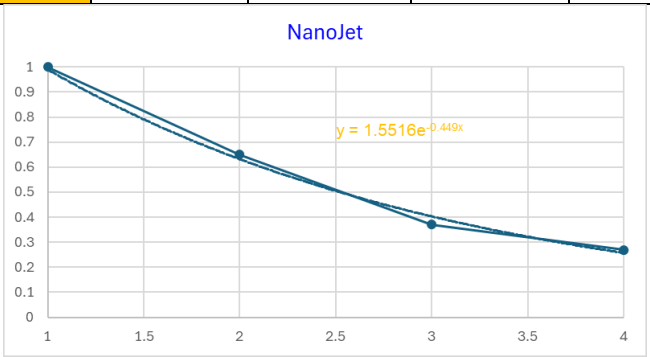


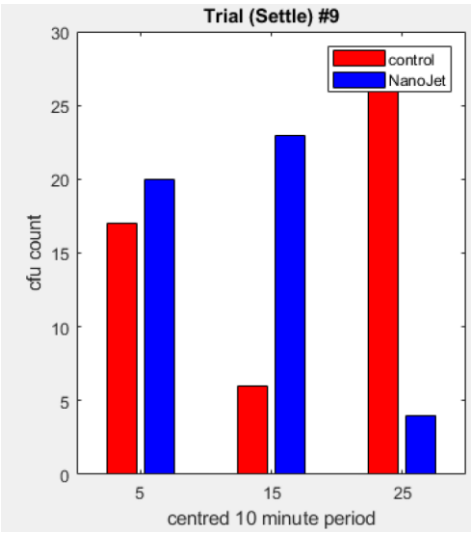


11/03/2025				
Control	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	138	1.00	17
	10	86	0.62	6
	20	96	0.70	26
	30	60	0.43	

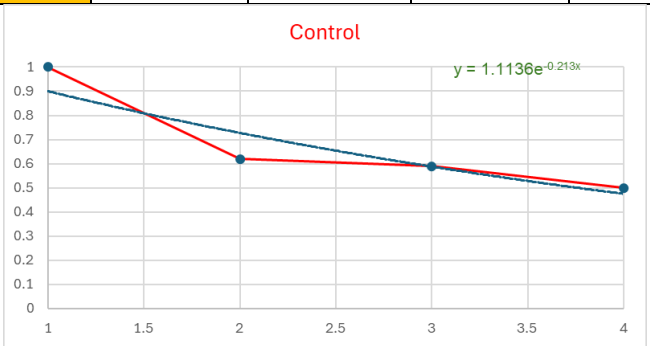


11/03/2025				
n=9	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	124	1.00	20
	10	80	0.65	23
	20	46	0.37	4
	30	33	0.27	

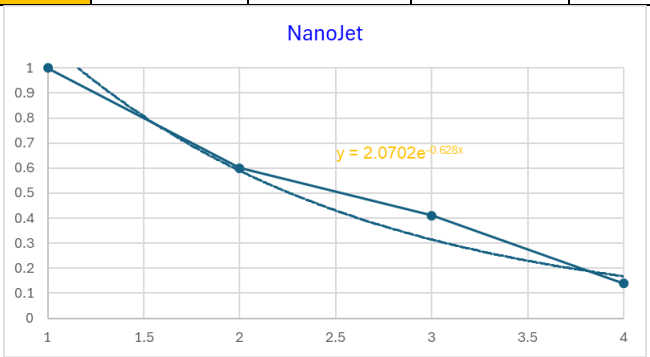


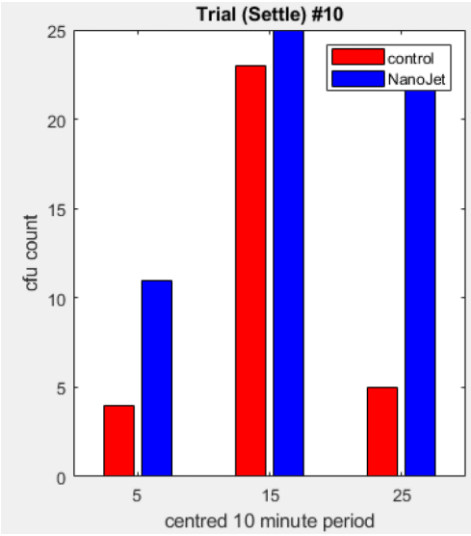


11/03/2025				
Control	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	145	1.00	4
	10	90	0.62	23
	20	85	0.59	5
	30	73	0.50	



11/03/2025				
n=10	Time (mins)	Counts	Norm.	Settle
	Init (Zero)	134	1.00	11
	10	81	0.60	25
	20	55	0.41	22
	30	19	0.14	





Summary Results

A and k determined from the runs *viz* $y = Ae^{kt}$

For illustration, parameters evaluated at Clearances [%] of 63.3, 90 & 99

Note: a Clearance of 63.3% corresponds to an equivalent x1 Air-Change-per-Hour (ACH) or 53m^3.

Run	Type	A (Scaling Constant)	k (Time Constant)	Residual [fractional]	Clearance [%]	Time [slot]	Time [mins]
#1	Control	1.1447	-0.22	0.37	63.3	5.13	41.34
				0.10	90	11.08	100.81
				0.01	99	21.55	205.47
	NanoJet	1.3416	-0.456	0.37	63.3	2.82	18.25
				0.10	90	5.69	46.94
				0.01	99	10.74	97.43
#2	Control	1.3656	-0.307	0.37	63.3	4.25	32.54
				0.10	90	8.52	75.15
				0.01	99	16.02	150.16
	NanoJet	1.0847	-0.324	0.37	63.3	3.32	23.20
				0.10	90	7.36	63.58
				0.01	99	14.46	134.64
#4	Control	1.3452	-0.276	0.37	63.3	4.68	36.77
				0.10	90	9.42	84.17
				0.01	99	17.76	167.60
	NanoJet	1.15	-0.405	0.37	63.3	2.80	18.00
				0.10	90	6.03	50.30
				0.01	99	11.72	107.16
#5	Control	1.354	-0.298	0.37	63.3	4.35	33.53
				0.10	90	8.74	77.44
				0.01	99	16.47	154.71
	NanoJet	1.356	-0.397	0.37	63.3	3.27	22.72
				0.10	90	6.57	55.67
				0.01	99	12.37	113.67
#7	Control	1.1929	-0.242	0.37	63.3	4.84	38.37
				0.10	90	10.24	92.44
				0.01	99	19.76	187.59
	NanoJet	1.633	-0.605	0.37	63.3	2.45	14.54
				0.10	90	4.62	36.17
				0.01	99	8.42	74.22
#8	Control	1.1339	-0.229	0.37	63.3	4.89	38.90
				0.10	90	10.60	96.04
				0.01	99	20.66	196.59
	NanoJet	1.633	-0.532	0.37	63.3	2.85	18.48
				0.10	90	5.31	43.07
				0.01	99	9.64	86.35
#9	Control	1.2008	-0.241	0.37	63.3	4.88	38.85
				0.10	90	10.31	93.14
				0.01	99	19.87	188.68
	NanoJet	1.5516	-0.449	0.37	63.3	3.19	21.93
				0.10	90	6.11	51.07
				0.01	99	11.23	102.35

#10	Control	1.1136	-0.213	0.37	63.3	5.17	41.73
				0.10	90	11.32	103.15
				0.01	99	22.13	211.26
	NanoJet	2.0702	-0.628	0.37	63.3	2.74	17.42
				0.10	90	4.83	38.25
				0.01	99	8.49	74.92

Time [mins] @ Clearance of x1 ACH (63.3%), x1 & x2 log10 reductions after application CDa Pro for 10 mins			
	63.3%	1 x log10	2 x log10
Mean Control	37.75	90.29	182.75
Mean NanoJet	19.32	48.13	98.84
Median Control	38.61	92.79	188.13
Median NanoJet	18.36	48.62	99.89

Run	Type	0-10 mins	10-20 mins	20-30 mins
#1	Control	22	10	10
	NanoJet	18	10	3
#2	Control	25	3	16
	NanoJet	10	1	21
#4	Control	6	24	11
	NanoJet	11	25	8
#5	Control	30	24	24
	NanoJet	36	6	21
#7	Control	7	3	4
	NanoJet	27	4	19
#8	Control	25	6	10
	NanoJet	11	2	0
#9	Control	17	6	26
	NanoJet	20	23	4
#10	Control	4	23	5
	NanoJet	11	25	22

CFU on passive settle plates after application CDa Pro for 10 mins			
	0-10 mins	10-20 mins	20-30 mins
Mean Control	17	12.38	13.25
Mean NanoJet	18	12	12.25
Median Control	19.5	8	10.5
Median NanoJet	14.5	8	13.5